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R. W. Manners
Director
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Science & Technology
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Laminated Composite Material Fracture Under Surface Impact

907D0170B Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 90 pp 225-230

[Article by V. V. Bolotin, A. A. Grishko, V. N. Shchugorev, Moscow Energy Institute and Machine Science Institute imeni A. A. Blagonravov at the USSR Academy of Sciences, Moscow]

[Abstract] Fracture of laminated composites under a surface impact is examined allowing for the substantial inhomogeneity and considerably nonlinear properties of the composites which are partly due to the microscopic damages scattered in the composite. The interaction of deformation waves with both layer boundaries and free boundaries formed as a result of impact fracture are taken into account. An analysis of a unidimensional model problem of a laminated, regularly structured material medium capable of plastic deformation, accumulation of microdefects, and fracture by tearing made it possible to carry out a qualitative study of the phenomena accompanying the fracture of laminated composites under impact. The contribution of secondary deformation waves forming as a result of reflection from the layer boundary and composite cracking is estimated. References 15: 13 Russian, 2 Western; figures 5.

UDC 539.3:678.06

Failure of Angle Ply Organic Plastics Under Axial Compression

907D0170C Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 90 pp 231-236

[Article by Ya. A. Anderson, V. A. Limonov, V. P. Tamuzh, Polymer Mechanics Institute at the Latvian Academy of Sciences, Riga]

[Abstract] A model for analyzing filament wound composites under axial static or cyclic loading is described. A ply separation criterion is derived by analyzing the torque stresses appearing in the layers after the cracking of the binder. It is shown that a ply-by-ply failure analysis allowing for ply separation is consistent with experimental data. A physical interpretation and a method of determining the applicability of the failure criterion of an angle ply composite are given in the framework of the above failure analysis. This analysis' applicability to calculating static and fatigue strength of an angle ply composite under axial loading with respect to the ply separation is shown. References 20: 13 Russian, 7 Western; figures 4.

UDC 629.7.023:621.772:539.3

Nonlinear Problems of Designing and Straining Composite Pressure Bottles

907D0170D Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 90 pp 286-291

[Article by A. B. Mitkevich, V. D. Protasov]

[Abstract] The problems of designing filament-wound pressure vessels are reviewed. Design applications are considered in the framework of two inelastic filament models, with equal and unequal polar openings. Models of design development problems based on final state criteria for an elastic filament are described. Examples of the solution of primal and inverse shell straining problems are cited. With respect to methods of analyzing inelastic filament shells, nonlinear design models make it possible to improve the initial and final pressure vessel shapes substantially allowing for the filament rigidity and more real fastening conditions. The inelastic filament model may be successfully used for determining forces in the filament. References 9: 7 Russian, 2 Western; figures 6.

UDC 624.072+539.374

Composite Panel Stability to Compression and Shear

907D0170E Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 90 pp 351-353

[Article by N. S. Azikov, V. V. Vasilyev, A. D. Paterekas, Moscow State Historic Archives Institute, Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy, and the Molniya Scientific Production Association, Moscow]

[Abstract] Composite plates with a high specific strength and flexural rigidity are widely used as load-bearing panels of thin structures, especially aircraft and ships. In most cases such panels are regarded as orthotropic and freely supported along the contour, as well as symmetric relative to the median surface, thus insuring the maximum flexural rigidity. Stability of such panels in compression and shear is analyzed. A numerical solution of the problem of the shear stability of a hinged tetragonal orthotropic plate is obtained. The buckling stability for a representative range of geometric and rigidity parameter variations of composite panels is summarized. It is shown that under compression combined with shear, the traditional parabolic relation of critical values of normal and tangential stresses is valid. References 2: Russian; figures 2; tables 1.

UDC 669.71-419.8:534.142

Acoustic Emission Parameter Sensitivity to Al-B Composite Defects

907D0170F Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 90 pp 354-357

[Article by Ye. P. Sokolova, N. F. Lyutikov, V. V. Chubuk, V. N. Mankevich, A. V. Rebrov, V. A. Artyukh, Mogilev Branch of the Engineering Physics Institute at the Belorussian Academy of Sciences and Metallurgy Institute imeni A. A. Baykov at the USSR Academy of Sciences, Moscow]

[Abstract] High-modulus nonmetal fibers such as silicon carbide, boron, and carbon, are promising materials for making fiber-reinforced composites. The sensitivity of the principal acoustic emission parameters to defects in Al-B fiber composite materials is estimated. In particular, sensitivity under local heating to varying degrees of composite fiber reduction was examined. In addition, the effect of a foil layer on the fiber composite material was analyzed. During the repeat loading, Kaiser effect was observed in all cases. Data on the acoustic emission signal amplitude distribution make it possible to draw some important conclusions on the fiber reduction degree in the composite. It is established that the foil layer has little effect on the sample strength. The proposed amplitude analysis of acoustic emission signals makes it possible to determine various defects inherent in fiber-reinforced composites without modifying the sample material structure. References 5: Russian; figures 5.

UDC 539.3:678.067

On the Accuracy of Effective Characteristics in Composite Materials Mechanics

907D0173A Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 90 pp 408-413

[Article by B. Ye. Pobedrya, Moscow State University imeni M. V. Lomonosov]

[Abstract] A mathematical model of a composite material is described by coordinate-wise discontinuous mass functions; this distinguishes the mechanics of composites from the mechanics of an inhomogeneous deformable mass. At each modeling stage, the problem of accuracy arises; the acceptable accuracy of experimental mass function measurements and whether it must be matched with the accuracy at other analysis stages. There is another important issue in the mechanics of composites: The accuracy to which the analysis is consistent with the check experiment, i.e., the model selection. Accurate effective characteristics of the mechanics of composites are defined. Methods of deriving these characteristics are illustrated by elastic and viscoelastic inhomogeneous media. The resulting formulas can be used for examining the notch sensitivity index and deformation concentration in composites as well as in establishing their failure criteria. References 14.

UDC 536.21:678.664

Estimation of Thermal Conductivity of Foam Plastics

907D0173B Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 90 pp 432-436

[Article by M. P. Gailite, A. M. Tolks, A. Zh. Lagzdin, A. E. Terauds, Polymer Mechanics Institute at the Latvian Academy of Sciences, Riga]

[Abstract] Low thermal conductivity λ is one of the most valuable technical characteristics of foam plastics; it depends on both their cellular structure and thermal properties of the polymer base, as well as the type and content of gas in the voids. Simple models for calculating λ are proposed; they are based on the orientation averaging method. Calculation results are compared to experimental λ values of foam plastic which differ in density and the ratio of closed and open pores. A rather adequate consistency of the analytical and experimental data is found for closed-pore foams, making it possible to use these models with an accuracy suitable for practical purposes in estimating thermal conductivity within a broad density range. More accurate calculations require data on the gas composition in the pores; these data can be obtained by determining the base polymer permeability and gas solubility; and by solving the equation of gas diffusion into the polymer matrix. References 10: 7 Russian, 3 Western; figures 2; tables 2.

UDC 536.4:539.4:678.067

Deformation and Strength of Degrading Heat Insulating Materials

907D0173C Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 90 pp 460-468

[Article by Yu. I. Dimitriyenko, I. S. Yepifanovskiy]

[Abstract] Polymer composites which degrade at certain temperatures and absorb heat in the process are widely used as heat insulating coats. A model of a laminated polymer composite behavior at high temperatures which makes it possible to take into account the physical and chemical characteristics of the binder decomposition and the attendant significant changes in the physical and mechanical properties of the material is proposed. The model can be used to analyze the deformation and strength of heat insulating composite coats. The model's diagnostic variables correspond to a viscoelastic body susceptible to damage. These relations take into account the transition from reversible to irreversible property changes in the polymer composite with a temperature rise from a relatively low to a higher level, as well as the

composite shrinkage. Two types of fabric polymer composite failure are formulated, due to ply seperation and due to either the fiber rupture or loss of stability. It is shown that the pressure of gaseous binder decomposition products in the pores may cause a ply separation under heating. References 11; figures 5.

UDC 629.735.33.015.4

Peculiarities of Insuring the Strength and Service Life of Polymer Composite Aircraft Structures Allowing for Their Susceptibility to Damage

907D0173D Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 90 pp 469-479

[Article by A. F. Selikhov, V. F. Kutinov, A. Ye. Ushakov, Central Aerohydrodynamics Institute imeni N. Ye. Zhukovskiy, Moscow]

[Abstract] Polymer composite materials (PKM) based on thermoplastic or thermosetting matrices reinforced with carbon, organic, glass or ceramic fibers have a high specific strength and rigidity and are resistant to crack nucleation and propagation under the effect of alternating loads or aggressive media; they are expected to be able to insure the strength and service life of aerospace structures. Special attention in the study is given to identifying the patterns of the damage development and spread in PKM, determining the PKM airplane structure susceptibility to damage during the manufacturing and operation, insuring the necessary PKM crack resistance and failure strength under mechanical impact, and using design and production methods of improving the operational survivability characteristics. Some PKM shortcomings, such as stress concentration sensitivity under static loading, diversity of failure types, and brittleness under mechanical impact are discussed. The evolution of design principles of load-bearing members of PKM aerospace structures is analyzed. References 8: 7 Russian, 1 Western; figures 7; tables 2.

UDC 678.02:538.6

Spatial Distribution of EDT-10 Lattice Components in the Layer Next to a Conducting Surface—Source of a Nonuniform Constant Magnetic Field

917D0034A Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 783-789

[Article by Yu. P. Rodin, Yu. M. Mochanov, Latvian Academy of Sciences Polymer Mechanics Institute, Riga]

[Abstract] Using IR spectroscopy, the authors study the spatial distribution of the molecules of EDT-10 epoxy cured in a nonuniform constant magnetic field over a thin layer on a conducting surface. A drop of EDT-10 was deposited on a 10 x 3 x 0.3 mm copper plate coated with a 5 micron layer of teflon, and the epoxy was pressed out to a uniform thickness of between 17 and 22 microns with a brass holder. The sample and a control were cured at 100 |SDC for 1 h, then ramped up to 150 |SDC and held there for 2 h, while passing a 100 A current through the plate. IR spectroscopy indicates a shift in the maxima of absorption bands associated with benzene rings, and the polar optical density distribution of these bands in polarized light was determined. Distortions in these polar diagrams confirm that the benzene rings, possessed of highly anisotropic magnetic permeability, are most affected by the orientation of the magnetic field. This leads to formation of the strained anisotropic lattice indicated by absorption maxima shifts. This anisotropic disposition of epoxy molecules along the conducting surface facilitates a stronger adhesive action with the binder in actual composites. References 13: 12 Russian, 1 Western; figures 5.

UDC 539.612

Changes to the Interface During Adhesive Interaction of Polyethylene and Steel

917D0034B Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 789-794

[Article by M. M. Kalin, Riga Polytechnic Institute]

[Abstract] This article explores the changes taking place in the adhesive interaction region of a polyethylene-steel interface. From wetting angle measurements, the surface free energy and percentage of the surface covered by polymer were determined for bonds broken along the polyethylene boundary layer, neatly along the polyethylene-steel interface itself, and by dissolving the polyethylene layer. An increase in the polymer surface free energy due to contact thermal oxidation is detected, corresponding to an increase in the number of strong adsorptive bonds in the polymer chains and hence increased resistance to delamination of the polyethylene-steel adhesive bond. The dependence of various bond parameters (surface free energy, surface coverage and resistance to delamination) on filler content and contact temperature is determined to study the effect of a talc filler on the bond; fillers like this improve bonding strength by adsorbing the low molecular weight byproducts of contact thermal oxidation destruction. References 20: 15 Russian, 5 Western; figures 5.

UDC 539.4:678.067

Distribution of Self-Equalizing Stresses in Twisted Fiber Composite Materials

917D0034C Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 803-811

[Article by S. D. Akbarov, Azerbaijan Academy of Sciences Mathematics and Mechanics Institute, Baku]

[Abstract] The distribution of stresses in a twisted fiber composite material is studied analytically, based on a model of a piecewise-continuous solid with a sufficiently small number of such fibers and negligible interactions between the fibers, and using three-dimensional linear

elasticity theory. The resulting equations in Papkovich-Neuberg cylindrical coordinates form are solved numerically. The variation of the self-equalizing tangential and normal stresses at the fiber-matrix interface with respect to dimensionless spatial distribution parameters is determined. References 4: 3 Russian, 1 Western; figures 5; tables 3.

UDC 539.319:678.02

Optimization of Hybrid Anisotropically Spiral Composites

917D0034D Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 812-816

[Article by N. A. Karvasarskaya and G. Ye. Freger, Lugan Machine Building Institute]

[Abstract] Structurally optimizing the shape of the components and the percentage of filler in a composite material based on hybrid spatially reinforcing filler, so that the best combination of elastic and strength characteristics are obtained is studied in this article. Since material breakdown occurs primarily because the load capacity of nucleus or matrix within the spiral reinforcing component is exceeded, the efficiency function here looks at the case of identical stresses on both. With the constraints that the elasticity modulus is much greater than that of a straight fiber-reinforced filler, and satisfaction of the Fisher strength criterion (a particular case of the generalized Goldenblatt-Kopnov criterion), the efficiency function is optimized numerically with respect to a variable representing the percentage of filler in the nucleus and layer. Analysis of one- and two-axis tensile and transverse shear stress shows that the optimal shape of the reinforcing component is nearly elliptical, fairly independent of the type of primary and secondary reinforcement used, and determined primarily by the characteristics of the applied load. References 6: 5 Russian, 1 Western; figures 2; tables 1.

UDC 536.2:678.067

Thermal Conductivity of Unidirectionally Reinforced Hybrid Composites

917D0034E Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 817-822

[Article by V. A. Kochetkov; Latvian Academy of Sciences Polymer Mechanics Institute, Riga]

[Abstract] Samples of unidirectional equally-reinforced three-component composite materials (polymer binder reinforced with two kinds of either plastic, glass or carbon fibers) are tested experimentally to determine how the thermal conduction depends on the content and combination of the various kinds of fibers. Data from measurement of the transverse and longitudinal thermal conduction coefficients are tabulated. These are compared to the results of a theoretical analysis of a three-phase model and found to satisfactorily agree. References 9: 8 Russian, 1 Western; figures 4; tables 2.

UDC 539.3

Effective Thermo-Piezoelectric Properties of Laminar Composites

917D0034F Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 823-830

[Article by R. I. Karalyunas, Vilnius University imeni V. Kapsukas]

[Abstract] Using averaging methods and starting from a mixed initial boundary condition description, the effective characteristics of laminar periodic-structure thermo-piezoelectric composites with randomly anisotropic components are studied analytically. The cumbersome equations are simplified by assuming that the properties are periodic functions of a single coordinate (the same one for all), yielding averaged expressions for the elasticity modulus, piezoelectric coefficient, dielectric constant, heat capacity, thermoelastic, heat conduction and pyroelectric coefficients. Five different composites made up of trigonal 3m tourmaline, trigonal 32 α-quartz, rhombic 222 Rochelle salt and hexagonal 6mm barium titanate ceramic were postulated, their properties calculated from the equations, tabulated and graphed. References 13: Russian; figures 3; tables 2.

UDC 620.22-419.8:539.4

The Effect of Structural Parameters on the Mechanical Properties of Angle-Ply Composites

917D0034G Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 831-835

[Article by V. S. Dobrynin, Ye. Yu. Filippova and A. Kh. Kayretdinov, USSR Academy of Sciences Machine Sciences Institute imeni A. A. Blagonravov and VIAM NPO, Moscow]

[Abstract] Two types of carbon plastic, one ELUR-0.08P carbon strips in a thermoplastic polysulfonic binder matrix and the other UKN-P/5000 carbon complex filament in an epoxy matrix, were built up by directly pressing a number of layers together at a variety of angles. The mechanical properties of small samples of these plastics are then measured, tabulated and graphed. For samples with transverse reinforcement plies, the deformation properties of the matrix have a decisive impact on crack formation in the material. The failure properties of the materials were determined using a computer structural simulation model to analyze the gradual accumulation of fiber breaks during monotonic increase in load and establish the point of macroscopic failure. The deformation properties of the matrices turn out to have a significant influence on the obtained strength of a unidirectional layer in angle-ply carbon

plastics: The thermoplastic matrix, with its higher elongation limit, has more than double the obtained strength of the epoxy matrix in the 0-45-90 degree stacking geometry. References 5: Russian; figures 2; tables 4.

UDC 539.3:539.4

A Method for Calculating Fatigue in Laminar Composite Shells and Plates

917D0034H Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 871-876

[Article by I. G. Teregulov and E. S. Sibgatullin, Kazan Engineering Construction Institute and Kamsk Polytechnic Institute, Poberezhnyye Chelny]

[Abstract] Strength criteria are proposed for orthotropic materials under cyclic loading which are a generalization of the Hay diagram to the case of complex multidimensional stress-strain states. A hypothesis is made about the variation in kinematic characteristics with respect to the thickness of the stacked plies and from this, parametric equations are derived for the extremal surfaces in the space of internal force and moment, means and amplitudes for laminar shells and plates. By way of example, the load capacity is found of a closed cylindrical shell built up by winding orthotropic layers and cyclically loading it with varying internal pressure and axial forces. References 16: 14 Russian, 2 Western; figures 2.

UDC 624.074.4:539.216.1

Geometrical Aspects of Techniques for Manufacturing Lattice Shells Using the Transformation Method

917D0034I Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 917-922

[Article by A. S. Cherevatskiy, Kazan Chemical Engineering Institute imeni S. M. Kirov]

[Abstract] One technique for manufacturing shells made of composite materials consists of winding two intersecting curve families of filaments over the shell, completely covering it, and then coating this with binder. Before the binder hardens, the shell may be transformed into some other shape having a non-geodesic shell lattice. For an inextensible lattice, in which one family of curves (filaments) may not move relative to another, this article addresses the problem of determining what shape of shell they should be wound onto so that they may be mapped or transformed into the desired shape before hardening. Solution of derived differential equations involving the surface metric tensors yields this desired shape and the geodesic equation for the windings on it. A sample calculation is performed for a vessel in the shape of a cone with a rounded (shell of revolution) bottom, showing that the desired initial shape is a part of a torus. References 5: Russian; figures 4.

UDC 539.4.32+620.1

Thermal Expansion of Composite Diamond-Containing Materials as a Function of the Bonding Along Phase Boundaries

917D0034J Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 923-926

[Article by A. L. Maystrenko and V. I. Suprun, Ukrainian SSR Academy of Sciences Superhard Materials Institute, Kiev]

[Abstract] The authors found the thermal expansion coefficient of 5 x 5 x 10 mm prismatic samples of four diamond-containing composite materials as a function of the concentration of AS50 synthetic diamond and its bonding characteristics with a glasslike ST.30 + Al_2O_3 matrix, a VK6 matrix (as in Slavutich and Tvesal), or a VK6 + Cu matrix. It was found that increasing the diamond content lowered the effective thermal expansion coefficient in all but the VK6 + Cu composites. It is shown analytically that this could be due to a lack of adhesion between diamond and matrix, and so the material acts as if it were porous. The theoretical dependences thus obtained are in agreement with the experimental data. References 8: Russian; figures 1; tables 1.

UDC 541.67:678.01

Viscoelastic Properties of Star-Shaped Polymers

917D0034K Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian 05, Jul-Aug 90 pp 926-928

[Article by I. I. Perepechko, V. P. Levin, Z. Ye. Tekutyeva and A. Ya. Goldman, Moscow Automated Mechanics Institute and Okhtinsk Plastpolimer NPO, Leningrad]

[Abstract] Star-shaped polymers of the form $(SB)_4Si$ and $(BS)_4Si$, where S is a polystyrol unit and B is a polybutadiene unit, are investigated using induced resonance oscillations (around 200 Hz) of a sample fastened on one end. The speed of sound in the medium (to within 2 percent), dynamic Young's modulus (4 percent) and tangent of the mechanical loss angle (5 percent) were measured as a function of temperature using this low-frequency acoustic method. The polymers resemble two-phase systems, in that there are clearly exhibited relaxation regimes corresponding to vitrification of the polystyrol and polybutadiene units. The results confirm the authors' contention that a polystyrol unit on the end of the arm of a star-shaped polymer tends to hinder the dense packing of polybutadiene units; these units in $(BS)_4Si$ samples are flexible chains and pack easily, and this yields a denser sample with higher modulus. References 1: Russian; figures 3.

UDC 669.15.194.2:621.983.621.96

New 24Kh2NAch High-Strength Steel for Smooth-Edge Blanking

907D0196A Moscow STAL in Russian No 8, Aug 90 pp 76-79

[Article by D. F. Cheprasov, V. V. Svishchenko, Ye. N. Nefedov, Yu. P. Gamarnik, M. L. Plepper, Altay Polytechnic Institute and Donetsk Metallurgical Works]

[Abstract] The results of an investigation of a pilot commercial batch of cold-rolled strip steel 24Kh2NAch smelted at the Donetks Metal Works as well as the results of industrial tests of drilling rigs made from this steel by the smooth-edge blanking method are presented. Steel was smelted in basic open hearth furnaces without oxygen blasting using up to 20 percent scrap metal in the charge. The ingots were rolled in a blooming mill, heated in a continuous furnace to 1100°C, and rolled into strips. After malleablizing, surface treatment and sizing, the billets were spheroidized. The structure of the resulting rolled stock and its mechanical properties were examined. The effect of rare earth metal additions on the phase composition and mechanical properties was analyzed. The results of acceptance tests of rolled strips show that the developed composition and smelting technology make it possible to attain good mechanical properties. Resistance to brittle failure and crack nucleation and propagation as well as impact strength were measured. It is shown that the new technique can save 250 rubles/ton of rolled stock or 5600 rubles/km of chain. The steel can be recommended for broad applications for heavily loaded parts of machines made by the smooth-edge blanking, cold forging and upsetting for operation at extremely low temperatures of the Far North. References 4: 3 Russian, 1 Western; figures 4; tables 1.

UDC 669.15-194.2:061.3

Steels Microalloyed With Vanadium

907D0196B Moscow STAL in Russian No 8, Aug 90 pp 79-80

[Article by N. M. Fonshteyn, Central Science Research Institute of Ferrous Metallurgy]

[Abstract] The reports presented to an international seminar held in the Polish city of Krakow on 23 - 26 April 1990 are summarized. The seminar was organized by Stratcor (U.S. Strategic Materials Corporation) for the countries of Central Europe. Some 100 experts from the USSR, Bulgaria, Czechoslovakia, [the former] East Germany, Romania, Hungary, Yugoslavia and Poland, as well as Sweden, the United States, and England and officers from Stratcor's Austrian branch participated in the seminar which was chaired by M. Korczinski. The issue of microalloying dominated the seminar. The chairman noted that the rising interest in microalloying was largely due to economic considerations since small additions of alloying elements make it possible to effectively improve the quality of products with minimal outlays. The "nitrovan" alloy developed by the company makes it possible to switch from vanadium carbide hardening to using vanadium nitrides, thus resulting in the same unique effect but with much lower vanadium outlays and greater grain reduction. The use of vanadium nitrides in combination with 0.01 - 0.02 percent titanium additions for the so-called recrystallization rolling which makes it possible to attain a high yield stress in low-carbon weldable steel is described. Other aspects of the vanadium microalloying technology were also discussed. The outlook for increasing the use of the "nitrovan" alloy which represents nitrided vanadium carbide in the future was addressed.

UDC 669.15-194.55

Structure and Properties of Maraging Corrosion-Resistant Steels With Various Cobalt Concentrations

907D0197F Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 36-39

[Article by N. A. Sorokina, N. A. Pavlenko, N. V. Andrushova, O. B. Belyakova, Yu. I. Rusinovich, Ferrous Metals Science Research Institute imeni I. P. Bardin]

[Abstract] The relationship between the structural state of corrosion resistant maraging steels with various cobalt concentrations and the features which determine resistance to brittle failure as well as strength properties is examined. It is shown that the addition of cobalt to maraging corrosion resistant steel 03Kh9N9M3 increases the amount of retained austenite in its structure (to a lesser extent in the hardened state and to a greater extent after aging) and enhances the maraging process. At least 10 percent cobalt must be added in order to stabilize retained austenite at low temperatures in the hardened state after aging; an increase in the cobalt concentration from 0 to 10 percent increases the post-aging strength from 1220 to 1380 N/mm^2 while insuring sufficient ductility and impact strength; and the hydrogen embrittlement resistance reaches its minimum given a cobalt content of 5 percent and reaches a level typical of cobalt-free steel at a concentration of 8 - 10 percent. References 5; figures 8; tables 1.

UDC 669.15'24'26'295-194:620.178

Effect of Titanium on Brittle Failure Resistance of 08Kh15N5D2T Maraging Steel

907D0197G Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 40-43

[Article by T. M. Makhneva, Ye. S. Makhnev, Engineering Physics Institute at the Urals Branch of the USSR Academy of Sciences]

[Abstract] It is established that 08Kh15N5D2T steel shows a tendency to embrittlement during aging. The effect of small additions of titanium (under 2 percent) on the impact strength after aging and its dependence on the grain size and retained austenite content in 08Kh15N5D2T maraging steel smelted in a lab are investigated. To this end, ingots with various concentrations of titanium and carbon to be studied were forged into bars which were then homogenized for 4 h at 1200°C. The recrystallization tendency was examined after heating the samples to 700 - 1200°C at a 100°C step, exposing them for 30 min, and cooling them in water. Experimental data demonstrate that additions of small quantities of titanium do not have an unambiguous effect on the phase composition and mechanical properties of low-carbon steel 08Kh15N5D2T and similar brands and that these properties depend on the correlation between titanium, carbon and nitrogen in these steels. References 4; figures 6; tables 1.

UDC 620.186:669.15'74-194

High-Strength Austenite Steels With Tungsten

907D0197I Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 50-51

[Article by V. M. Kardonskiy, O. V. Samoylova, Ferrous Metals Science Research Institute imeni I. P. Bardin]

[Abstract] Austenite steels which differ in their tungsten, manganese and carbon content are examined in order to analyze one of the shortcomings of high-manganese austenite steels—their relatively low yield strength. Steels were smelted in an induction furnace and ingots were forged into square bars at 1150 - 1200°C. Some of the metal was hardened in water beforehand from 1200°C. The results show that by alloying austenite high-manganese steel with tungsten one can increase the yield point by 100 - 250 N/mm^2; steels with 15 - 20 percent Mn, 10 percent W, and over 0.65 percent C have the best set of mechanical properties in the initial and hardened states; and that cold work hardening makes it possible to increase the yield strength to 1500 - 1600 N/mm^2 while retaining satisfactory ductility. References 2: 1 Russian, 1 Western; figures 3; tables 3.

UDC 669.1.017

Use of Bainite Steels to Attain High-Strength Condition

907D0199A Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 138 No 2, May 90 pp 357-364

[Article by V. I. Kopaleyshvili, O. G. Ioseliani, I. K. Kashakashvili, F. N. Tavadze (deceased), Georgian Engineering University]

[Abstract] The new 40GFM and 40GSMF medium carbon bainite steels which are adaptable to mass production, economical and can be used to attain the high-strength condition without hardening and tempering are described. These steels can be used to make seemless tubes which, after normalizing, meet GOST 632-80 requirements. When cooled in the air, these steels insure an austenite decay according to the bainite mechanism. The effect of silicon content on various properties and the austenite decay was studied. Mechanical properties of steels as a function of the γ-α isothermal conversion temperature, hot plastic straining and cooling rate were investigated. The effect of steel "rejuvenation" whereby all mechanical indices, especially the elongation, improve after an exposure for 10 days to natural conditions or for 6 h to 100°C was discovered. It is shown that specially selected medium carbon bainite steels can be used to attain the high-strength state using a resource conserving technology and that rejuvenation is more economical than hardening and tempering or normalizing with high-temperature tempering. Tables 3.

UDC 669.187.56.001.3

The Role of Electroslag Process in Smelting Massively Nitrogen-Alloyed Steels

907D0200A Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3(23), Jul 90 pp 4-13

[Article by B. Ye. Paton, B. I. Medovar, V. Ya. Sayenko, V. A. Tikhonov, Electric Welding Institute imeni Ye. O. Paton at the Ukrainian Academy of Sciences, Kiev]

[Abstract] The place and role of electroslag process in the smelting of high-nitrogen (VAS) and massively nitrogen-alloyed steels (SVAS) are reviewed. Particular attention is given to the SVAS group even though its proportion in the total production of nitrogen steels is relatively low because SVAS cannot be produced without using the ESR technology. The views of various authors, both at home and abroad, on this issue are summarized. In particular, methods used in Bulgaria, [the former] West Germany and Austria are described and various SVAS smelting techniques as well as technological parameters of the ingot smelting are compared. Pressure die casting methods are analyzed and the methods of nitriding by adding nitrogen-containing ferroalloys or using nitrogen blast are presented. The authors draw the conclusion that the ESR method is called upon to play an important role in the future in smelting SVAS and that arc remelting and refining under high nitrogen pressure will replace the high-pressure electroslag remelting method. References 23: 15 Russian, 8 Western; figures 4; tables 2.

UDC 669.187.56.001.3

Technique and Equipment for Examining Nitrogen Absorption by Steels and Alloys Under Surplus Pressure

907D0200B Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3(23), Jul 90 pp 21-23

[Article by G. M. Grigorenko, Yu. M. Pomarin, V. Yu. Orlovskiy, Electric Welding Institute imeni Ye. O. Paton at the Ukrainian Academy of Sciences, Kiev]

[Abstract] An experimental unit developed at the Paton Institute for carrying out physical and chemical examinations of the nitrogen solubility in molten metals and alloys by smelting the metal in suspension while varying the partial pressure of nitrogen from 0 to 1100 kPa in the course of the process is described. The unit consists of a reaction chamber, a gas purification system, a gas rate meter and a power variator. The metal is melted in an induction heater by an electromagnetic field under excess nitrogen pressure. It is shown that an equation derived earlier by the authors can also be used to analyze equilibrium nitrogen concentrations in multicomponent iron alloys under high pressures. The authors conclude that the proposed technique can be used to examine both the thermodynamics and kinetics of nitrogen absorption by molten metals from the gaseous phase making it possible to simulate certain processes and determine the maximum attainable equilibrium gas concentrations in the metal. References 2; figures 3; tables 1.

UDC 669.018.6

Development of Alloys With Memory Effect

907D0198A Moscow TSVETNYYE METALLY in Russian No 8, Aug 90 pp 90-93

[Article by V. K. Larin, M. A. Kravchenko]

[Abstract] The good outlook for using materials with the memory effect is due to their use as the working medium of heat engines. Their principal advantage is the ability to directly convert low-temperature thermal energy into work. Various aspects of the use of different memory effect materials are reviewed and the performance of thermomechanical drives is analyzed. It is shown that the so-called martensite heat engines with Cu-Zn-Al, Cu-Al-Mn and Cu-Mn alloy working media are quite promising and cheaper than the Ni-Ti alloy-based machines. The use of thermomechanical drives in presses, guidance systems, final control elements, jacks, power wrenches and contactors is described. It is demonstrated that materials with the memory effect are the most efficient in automation and control devices as well as in probes for monitoring electrical parameters and in medicine. The conclusion is drawn that the use of alloys with the memory effect can insure a principally new level of engineering designs and help to save hundreds of thousands of tons of expensive and scarce nonferrous metals. References 21: 20 Russian, 1 Western.

UDC 621.74:669.715

Effect of Straining on Mechanical Properties of Sheets From Aluminum Alloys With 1 Percent Mg_2Si and 0.4 Percent Si

907D0198B Moscow TSVETNYYE METALLY in Russian No 8, Aug 90 pp 93-96

[Article by L. S. Toporova, D. G. Eskin, M. L. Kharakterova]

[Abstract] Al-Mg-Si-Cu alloys, for example, AV or AD33, are extensively used in various branches of industry, primarily in automotive engineering, due to their good combination of adaptability, mechanical properties and corrosion resistance. Various physical metallurgy aspects of the production of items from known Al-Mg-Si-Cu alloys as a function of concentration of the principal alloying elements are examined. In particular, aging without the intermediate straining was analyzed in AV alloys containing 0.63 percent Mg, 0.77 percent Si and up to 0.8 percent Cu. Mechanical properties were determined in tension using fivefold flat samples which were first hardened from 520°C in water for 1 h, then exposed for a month at room temperature and artificially aged at 177°C for 1 h. The samples were also strained by 5 and 10 percent in a tensile tester which corresponds to stretching during the forging. The effect of copper on mechanical properties of the alloy was investigated at various stages of the process. It is established that artificial aging increases the yield strength and results in cold hardening of the alloy as well as decreases its ductility. References 7: 5 Russian, 2 Western; figures 2; tables 1.

UDC 666.762:11-486

Industrial Production of Polycrystalline Oxide Fibers

907D0191A Moscow OGNEUPORY in Russian No 4, Apr 90 pp 34-36

[Article by L. A. Dergaputskaya, I. N. Kalinovskaya, N. M. Vasilyeva, R. B. Vasilchenko, Ye. V. Rozhkov, M. Z. Naginskiy, and O. G. Khomutova, Pervouralsk Dinas Plant]

[Abstract] In the 1980's, an industrial method was developed for manufacturing high refractory polycrystalline oxide fibers with usage temperatures over 1400°C. To achieve the most rapid possible introduction of this technology to practice, sections were set up and pilot-scale production started at a number of refractory enterprises. This article discusses the experience of the Pervouralsk Dinas Plant in setting up equipment according to drawings provided by the Ukrainian Scientific Research Institute of Refractories. The solution to the problem of heat treatment of the fiber was the creation of a roasting furnace of an original design developed at the plant and production of raw materials for the process. The major component used in the manufacture of the Al_2O_3 fiber is aluminum oxychloride. Photomicrographs are presented on the microstructure of the fiber produced at the plant. The fiber has excellent heat insulating properties. The plant is undertaking the manufacture of high-temperature plates based on this fiber capable of operation at up to 1600°C. The economic effect from the production of these aluminum oxide fibers at the plant in 1988 was 80,000 rubles. Figure 1, references 3: Russian.

UDC 008:666.76

Status and Prospects for Development of Production of New and Effective Refractory Products

907D0192A Moscow OGNEUPORY in Russian No 5, May 90 pp 1-6

[Article by Yu. D. Sagalevich and V. A. Kononov, USSR Ministry of Metallurgy]

[Abstract] The major reasons for the high rate of consumption of refractories in the USSR include the low percentage of continuous casting of steel, converter steel and electric-furnace steel, the low level of utilization of heating equipment, the low quality of refractories and the insufficient manufacture of progressive types of refractories. A re-equipping program has been undertaken to improve the technical level of production and quality of products produced. This article outlines the program in the area of new types of products and new technologies, mechanization and automation of production, design of refractory production facilities, and development of the raw materials base for refractory production. Refractory types include those for converter production, electric furnaces, steel casting, lining of steel-casting ladles, vacuum installations and various other types of heating installations for metallurgy and other industries.

UDC 666.762.5:621.352.1

Solid Electrolytes of Zirconium Dioxide With Conductive Coating

907D0192B Moscow OGNEUPORY in Russian No 5, May 90 pp 10-14

[Article by N. A. Likhomanova, Yu. S. Toropov, and M. G. Tretnikova, Eastern Institute of Refractories]

[Abstract] A study is made of the possibility of producing ceramics from partially stabilized zirconium for use as solid electrolytes with simultaneous application of a coating permitting the formation of a cubic structure preventing growth into the monoclinic phase, helping to increase density and decrease the resistance of the solid electrolyte. Studies were performed on specimens of ZrO_2 partially stabilized with Y_2O_3 (6.2 percent by mass). The presence of a coating with the cubic modification of zirconium dioxide is found to protect the tetragonal phase from conversion to a monoclinic phase, prevent growth of the monoclinic phase into the depth of the product, resulting in an increase in its resistivity and loss of mechanical strength. The Cu_2O additive in the coating in combination with Y_2O_3 or rare-earth element oxides helps to decrease the resistivity of the solid electrolyte by 15 - 35 percent by increasing the share of electron conductivity in the surface layer. The coatings can be used with solid electrolytes in combustion monitoring sensors in motor-vehicle engines. Figures 5, references 8: 5 Russian, 3 Western.

UDC 666.762.52:621.352.1

Use of Yttrium Concentrate to Produce Solid Zirconium-Dioxide-Based Electrolytes

907D0192C Moscow OGNEUPORY in Russian No 5, May 90 pp 14-17

[Article by T. V. Chusovitina, Yu. S. Toropov, G. S. Matveychuk, B. G. Antonov, V. F. Duvanov, and G. A. Panchuk, Eastern Institute of Refractories]

[Abstract] A study is made of the physical and chemical properties of solid solutions of zirconium dioxide stabilized by yttrium concentrates. Some of the process parameters are given for the production of powders and products based on them. The content of yttrium oxide in the concentrate was 84 percent by mass, and it also contained other rare earth oxides. Powders were synthesized by chemical coprecipitation of the components from a solution of chlorides by ammonia at pH = 8.5 - 9. The powders were ground in a ball mill to 5 - 8 μm diameter and pressed at 100 N/mm^2 and roasted at

1600°C. The phase composition of the materials consisted entirely of a cubic solid solution. Solid solutions of zirconium dioxide with 17 - 18.5 percent yttrium concentrate have virtually the same conductivity as ZrO_2 - 16.5 percent Y_2O_3 but are much more subject to aging. Solid electrolytes of this composition can be used in electrochemical devices for cyclical short-term measurement of the oxygen content at over 600°C. Figures 2.

UDC 666.162.5

Ceramic Based on Partially Stabilized Zirconium Dioxide

907D0192D Moscow OGNEUPORY in Russian No 5, May 90 pp 17-20

[Article by I. F. Usatikov, Ye. I. Zoz, R. Ye. Volfson, N. M. Chudnova, Ye. B. Loyenko, G. A. Gogotsi, and V. I. Galenko, Institute of Strength Problems, Ukrainian Academy of Sciences]

[Abstract] A study is made of a zirconium ceramic in which the ZrO_2 was stabilized by solid-phase sintering. The Ukrainian Scientific Research Institute of Refractories tested the possibility of producing zirconium dioxide partially stabilized by yttrium oxide by this method. The difference between the new method and previously reported methods is the lower roasting temperature of briquettes produced from the oxides which were ground together. The partially stabilized ceramic produced is suitable for the manufacture of parts operating under high temperature conditions including in situations where vapor is formed. Figures 5; references 9: 7 Russian, 2 Western.

UDC 666.3.0.17:620.174

Production of Noncalcaned Quartz Ceramic by Soaking in Liquid Glass

907D0193A Moscow OGNEUPORY in Russian No 6, Jun 90 pp 5-8

[Article by I. S. Matusevich, "Kvarts" Scientific-Production Association]

[Abstract] An aqueous solution of ammonium nitrate was used to remove the sodium in sodium silicates, which are the binding base of liquid glass, used to give high strength to noncalcaned ceramic. Ammonium nitrate was selected because when it interacts with the liquid glass it forms sodium nitrate, which is highly soluble in water (three times more than sodium chloride) and is therefore easily removed from the ceramic to provide high-temperature strength. Products and specimens formed by slip casting of a quartz ceramic, followed by 2 hours of air drying, were soaked for 24 hours in a liquid glass solution, then extracted, allowed to drain for 1 - 2 minutes and immediately submerged in an aqueous solution of ammonium nitrate for 20 - 24 hours. Following washing in tap water, the ceramic contains pure silicon dioxide, giving it good high temperature strength. The ceramic is significantly superior to ordinary ceramics calcaned 200 - 1200°C. Treatment of the products in aqueous solutions of the nitrates of ammonium, chromium, magnesium, zirconium, berryllium and cerium produces a quartz ceramic containing the oxides of these metals and having good metal and slag resistance. Figures 4; references 13: Russian.

UDC 666.762:535.34

Radiation Properties of Refractory Coating Components

907D0193B Moscow OGNEUPORY in Russian No 6, Jun 90 pp 35-37

[Article by I. I. Ionochkin, V. N. Zapechnikov, and A. G. Zenkovskiy, Moscow Evening Metallurgical Institute]

[Abstract] A study is presented of the spectral radiation properties of the components of refractory coatings in their initial state and in the process of heating to 1473 K. Specimens were heated by a radiant furnace containing a xenon lamp on a chamotte refractory disk substrate. Coatings included SiC, CuO, Cu_2O, Cr_2O_3, synthetic corundum and iron scale, particle sizes 0.1 - 0.65 μm. Studies were performed at wavelengths $\lambda = 0.75$ - 12 μm. The refractory coatings tested were found to have selective radiation properties. $\varepsilon_{\lambda,n}$ was determined as a function of wavelength and temperature, allowing the components studied to be used individually or in combination as coatings to improve the radiation characteristics of industrial furnace surfaces. Figures 2; references 4: Russian.

UDC 535.33:537.226

Radiative Recombination Spectra of Zinc Oxide Ceramics

907D0201A Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 52 No 4, Apr 90 pp 571-576

[Article by A. I. Proskura, V. Ya. Degoda, B. R. Kiyak, Kiev State University imeni T. G. Shevchenko]

[Abstract] Radiative recombination in ZnO ceramics at high excitation levels was examined and *M* and *P* bands and ultraviolet radiation were investigated. Ceramics were made by the hot molding method from a pure "phosphor" powder. A comparative study of these materials was made in the UV and green luminescence bands ($\lambda_{max} = 510$ nm) under X-ray and photoexcitation at 77 and 300K. The effect of production factors on the luminescence efficiency was analyzed in various spectral regions. An optimum molding temperature for making ZnO luminescence ceramics was found. Three bands—374.7, 383.4 and 392 nm—related to radiative multiphoton free exciton annihilation were obtained at 77K. For the $\lambda = 370.6$ nm wavelength radiation, an *M* band

was detected in ZnO ceramics at 77K. The authors conclude that zinc oxide microcrystals are stoichiometric and their characteristic structure is identical to the energy-band structure of ceramics and single crystals. The presence of intense exciton radiation and a rather weak green luminescence attests to the low concentration of uncontrollable impurities in ZnO ceramics. References 12: 10 Russian, 2 Western; figures 3; tables 1.

UDC 535.345:536.48

Cryostable Multilayer Coatings

907D0201B Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 52 No 4, Apr 90 pp 649-654

[Article by A. I. Belyayeva, S. N. Marushko, A. P. Silka, V. I. Khramtsova, R. G. Yarovaya, Engineering Physics Institute of Low Temperatures at the Ukrainian Academy of Sciences, Kharkov]

[Abstract] Cryogenic multilayer coatings which are transparent in the median IR band are synthesized. In general, the system consists of a base from a substance with a refractive index of 2.0 - 2.5 and the main and auxiliary multilayer coats deposited thereon. The thermal and mechanical strength of the synthesized coatings were tested and they were exposed to multiple thermal cycling within the 80 - 300 and 8 - 300K range under thermal shock or slow cooling conditions. The effect of ultrasound was examined at room temperature at a frequency of 22 and 44 kHz where water served as the transfer medium. All these tests as well as the exposure of samples to lab conditions for two years did not affect the spectral response of the base-coating system. It is shown that the selected set of materials made it possible not only to attain stable optical characteristics within a broad low temperature range but also to identify a number of positive properties (the ability to form strong layers in a vacuum and good adhesion, dilatometric compatibility and the lack of hygroscopicity) which insure good mechanical and thermal strength of multilayered coatings as a whole. References 7: 4 Russian, 3 Western; figures 2.

UDC 666.1.031.5:666.24

Electric Melting of Heavily Tinted Glass

907D0202A Moscow STEKLO I KERAMIKA in Russian No 8, Aug 90 pp 12-13

[Article by B. N. Prokhorov, A. T. Brazhkina, M. I. Sokolov, A. G. Lizunov, the Khrustal Scientific Production Association and Ivanishchi Glass Works]

[Abstract] Heavy glass tinting sharply lowers the melt's diathermancy and significantly complicates its heating uniformity which are necessary for obtaining high-quality products. The design of an electric furnace with molybdenum rod electrodes for smelting heavily tinted glass characterized primarily by the utmost current density decrease on the electrode surface is described. Glass with different chemical compositions was produced but cobalt oxide was used as the dye in all cases. Arsenic oxide-based bleaching agents were introduced in combination with 1 percent Na_2O. Arsenic oxide was subsequently substituted with cerium oxide. Spectral transmission curves of the resulting glass at varying dye concentrations are cited. The character of the temperature distribution in the melt depth in the smelting pool as well as the correlation between the temperature and the furnace's electric capacity are shown. Stable furnace operation and the high quality of the resulting glass demonstrate the need to switch from low-output combustion furnaces to electric melting. Figures 3; tables 2.

UDC 666.363.4:666.5

Flotation Feldspar Concentrate as a New Raw Material for Making Electric-Grade Porcelain Articles

907D0202B Moscow STEKLO I KERAMIKA in Russian No 8, Aug 90 pp 20-21

[Article by N. S. Demchenko, K. A. Kovaleva, V. S. Romanovskiy, V. I. Strelnikov, S. T. Frolov, Special Technological Design Office on Insulators and Fixtures at the Soyuzelektrosetizolyatsiya All-Union Production Association and the Slavyanka Fixture and Insulator Plant]

[Abstract] The use of flotation feldspar waste containing silicon, sodium, aluminum, potassium and ferric oxides for making faience and sanitary articles is described. The concentrate's technological properties are studied by comparing them to base compositions used at the Southern Urals and Slavyanka plants to insure conformity with state standards. Tests of standard samples confirm that samples of experimental composition-based porcelain meet state standard specifications. A pilot insulator batch passed mass, acceptance and standard tests. It is shown that flotation feldspar concentrate meets the requirements of GOST 7030-75 and is suitable for large-scale production of high-voltage insulators from electric-grade porcelain. The initial dispersion degree of the concentrate makes it possible to eliminate coarse and medium milling thus helping to decrease air contamination, lower noise and reduce electric energy outlays. References 2: Western; tables 4.

UDC 666.65.015.4:537.533

Sintering of Diopside Ceramics by Accelerated Electron Beams

907D0202C Moscow STEKLO I KERAMIKA in Russian No 8, Aug 90 pp 21-22

[Article by Yu. I. Galanov, T. S. Frangulyan, Yu. I. Alekseyev, Tomsk Polytechnic Institute]

[Abstract] Traditionally, many ceramic products are roasted by indirect heating in furnaces. This leads to considerable temperature gradients between the product's surface and deep layers. A high-energy electron beam sintering method which is free of said shortcomings is described. Heating is performed due to the energy dissipation of high-energy electrons as they pass through the sample thus heating the entire bulk of the sample simultaneously. The results attest to a substantial activation of the powder material sintering by the electron beam due to the accelerated mass transfer in the powerful radiation field. The possibility of using electron beam heating in order to accelerate the sintering of a dielectric ceramic consisting of diopsidite, Veselov's clay, boric acid and aluminum oxide is shown. Production of such ceramics was examined under two temperature rise conditions while varying the temperature and duration of isothermal exposure. The shrinkage, apparent density, water absorption, phase composition and conductivity were examined. The method makes it possible to considerably shorten the sintering process and save electric energy. The resulting ceramics have good electric and physical properties and may be used as insulators. References 4; figures 1; tables 1.

UDC 666.3.6:666.368

Binder for Molding Ceramic Products

907D0202D Moscow STEKLO I KERAMIKA in Russian No 8, Aug 90 pp 23-24

[Article by Ye. G. Piskunov, Interbranch Science Research Center of Engineering Ceramics at the USSR Academy of Sciences]

[Abstract] Today, increasing attention is being focused on reducing the consumption of edible materials for technical purposes by replacing them with synthetic and other materials. The use of a molding powder compound made of a coarsely ground three-phase system consisting of a mineral base, a fatty acid binder prepared from an olein solution in kerosene or a kerosene solution of a mixture of water-insoluble naphthenic acids and naphthenate soap, and air is described. The bending strength and other mechanical properties of ceramic semifinished products made from this composition are analyzed. Data of the concentration of various binder components and residual moisture content are summarized. Synthetic fatty acid-based binders have been awarded Author's Certificates Nos. 810642 and 885218 and are recommended for commercial uses, especially for molding complex-shaped ceramic products for the electrical engineering industry. Figures 1; tables 2.

UDC 666.1.037.5

Strength of Glass-Metal Seal in Color Picture Tube Hold Circuit Unit

907D0202E Moscow STEKLO I KERAMIKA in Russian No 8, Aug 90 pp 24-26

[Article by S. F. Kozlovskiy, P. D. Sarkisov, A. I. Tumas, Moscow Chemical Technology Institute imeni D. I. Mendeleyev]

[Abstract] During the vacuum heat treatment, 70 - 90 percent of picture tube fractures occur due primarily to the cracks developing in the hold circuit unit; such cracking results in a total loss of the tube thus making products much more expensive. The strength of the seal between the glass tube and the metal hold circuit unit is analyzed and the conditions which affect the development of cracks across the seal are examined. It is shown that the seal strength depends primarily on the quality of the oxide film on the metal which does not insure proper glass-metal adhesion, poor glass shape near the hold circuit part welded into it, hold unit metal flaws, and difference in the temperature course of the glass and metal cracking which leads to an increase in the stress concentration during the vacuum heat treatment. It is also shown that in order to increase the hold unit strength, it is necessary to insure the following five conditions in the picture tube: 1) develop a good oxide film adhesion with the metal, 2) remove gases dissolved in the metal beforehand, 3) dull the edge of the hold circuit unit's cylindrical part, 4) develop an optimum wetting meniscus, and 5) match the temperature course of the metal and glass expansion within the cooling temperature range. Figures 3.

UDC 678.664

Prospective Developments in Polyurethane Manufacturing

917D0038A Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 3-4

[Article by S. N. Fedotova, S. M. Andreyeva, N. G. Kirichenko and Ye. D. Loginova]

[Abstract] The authors give a brief review of the articles and products made from polyurethane in the Soviet economy, and review the figures for polyurethane production, satisfaction of the demand for polyurethane, and fulfillment of targets during the 12th Five-Year Plan. Overcoming shortages of polyurethane is one of the primary aims of the new plan for the industry, anticipated demand in 1995 is 640,000 tons—with 72,000 tons to machine building, 211,000 tons to construction, 90,000 tons to light industry, and 170,000 tons to the chemical and paper industry. To meet this demand, the raw materials supply and production infrastructure must be improved; this especially relates to production of diisocyanate. The technology and equipment currently used in the production of complex polyesters are inefficient, outmoded and worn out. The 13th Five-Year Plan specifies introduction of new models specifically designed to meet the needs of polyurethane production. Provision is made for improved disposal and cleanup of solid, liquid and gaseous waste. The authors point out that roughly 40 percent of the doubled output between now and 1995 will go into consumer goods. The need for cooperation between Minkhimnefteprom and Gosassotsiatsiya "Agrokhim" is stressed. References 2: Western.

UDC 678.072.033:536.6

Thermally Stable Arylcyanate-Based Polymer Matrices for Composite Materials (A Review)

917D0038B Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 5-11

[Article by V. A. Pankratov and A. Ye. Chesnokova]

[Abstract] A review is presented on the application of arylcyanates as matrices in new composite materials which are much more thermally stable than the epoxide oligomers. Methods for production of arylcyanates are discussed, including use of transition metals, metal salts, etc., as catalysts. Properties of some promising binders for materials to be used in electrical engineering are compiled. Areas of application for arylcyanate-based partially-interpenetrating lattices are discussed. The properties of polycyanurate, polycarbonate, polysulphone, copolyethylcarbonate and the partially-interpenetrating lattices based on them are tabulated and discussed, as are characteristics of promising composite materials for integrated chip manufacture. The authors reference more than 70 patents or patent applications from around the world. References 93: 23 Russian, 70 Western; tables 4.

UDC 678.675'126-492.2.01:66.066.7

The Effect of the Method of Precipitation From Solution of Powdered-Form Polycaproamide on Its Properties

917D0038C Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 11-13

[Article by N. I. Angelova and D. I. Pishev, Bulgaria]

[Abstract] This article examines the methods of precipitation of polycaproamide (PCA) and their effect on the basic technical characteristics of the obtained powdered-form PCA used in deposition of coatings. The powder was obtained from a 1 percent solution of PCA wire (viscosity 2.9 to 3.1, low molecular weight content up to 3.5 percent) in 95.6 percent H_2SO_4 at 293 K. The polymer content of the solution was 25 percent. The precipitation was effected by chilling the solution and adding water. The rate of cooling of the solution had a decisive effect on the resulting powder; moderate rates led to uniform, spherical particles, while rapid cooling had the opposite effect, increasing the porosity of the irregularly shaped particles and hence their surface area. For precipitation by addition of water, temperature and amount of precipitant were the major factors. An increase in the latter resulted in more phase stratification of the system and more amorphous, porous particles in the resulting powder. References 8: 6 Russian, 2 Western; figures 2; tables 1.

UDC 678.743.22:678.664.01-4.88

Deformation and Strength Properties of PVC + TPU Based Film Materials at Reduced Temperatures

917D0038D Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 14-16

[Article by A. S. Makarov, T. A. Yerykalova, M. P. Letunovskiy, V. V. Strakhov and S. V. Vladychina]

[Abstract] The authors measured and tabulated the values of breaking point tensile stress, ultimate induced elasticity, and relative elongation at fracture of PVC + TPU binary films of varying content at temperatures between 223 and 293 K. The films with less than 50 percent TPU content were deposited on shovel-like surfaces, those with more than 50 percent on ring-like samples with an inside diameter of 21 mm and 1 mm thickness. It was found that the relative elongation increased and ultimate elasticity decreased as the temperature was reduced. The authors propose that a sample may withstand falling-load tests at a given temperature if the ultimate elasticity at that point is not more than 50 - 55 MPa. A load-deformation curve was plotted, yielding some guidance on the lower bound for operating temperature of these materials under impact load. It was found that the lower the TPU content, the higher the temperature at which strain "necks" were formed in the samples under deformation. References 4: Russian; figures 2; tables 1.

UDC 678.675'126:539.2

Structural Changes and Properties of Polycaproamide Organic Plastic During Thermal Aging

917D0038E Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 19-22

[Article by O. V. Startsev, G. S. Golovkin, V. P. Dmitrenko and O. A. Serova]

[Abstract] The effect of various thermal oxidation aging conditions on the structure and properties of polycarpoamide organic plastics is studied. Orthotropic 1.5 mm thick sheets of PAP-SVM organic plastic reinforced with SVM filaments were pressed into blanks under 2.0 MPa pressure at 523 K for 15 min, then cooled under pressure down to 353 K. The blanks were tested for breaking point tensile stress, bending stress, and bending elasticity modulus, and the shear modulus, mechanical loss tangent, and low-frequency shear wave velocity were determined on a torsional pendulum at 293 - 573 K. The variation in mass and thermal expansion were also measured at each point. The samples were aged at 353, 373 and 393 for 500, 1000 and 2000 h. Aging was found to worsen mechanical properties of PAP-SVM organic plastic due to the oxidation processes occurring in both amorphous and crystalline PCA regions. This thermal oxidation destruction of the PCA matrix is

most apparent at 393 K, giving us some idea of the limits of applicability of PAP-SVM plastic. References 9: Russian; figures 4; tables 1.

UDC 678.742.2-13.5.473.911.01

Properties of Chemically Cross-Linked Reciprocal Lattice Polyethylene

917D0038F Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 26-28

[Article by L. P. Krul, Yu. I. Matusevich, L. Yu. Brazhnikova, N. G. Matveyeva and I. N. Musayelyan]

[Abstract] This article compares twelve physical and chemical properties of the initial polyethylene and salt vulcanizate based on the cross-linked copolymer polyethylene and acrylic obtained from a polymer melt in the presence of dicumyl peroxide as a cross-linking polymerization seed. The differences were slight, not more than might be permissible in the initial unmodified polymer. The spatial structure thus formed did increase its thermal stability appreciably. At the same time, the ionic nature of the spatial lattice sites allowed repeated working of the material without fracture, which is of considerable economic importance. References 11: Russian; figures 2; tables 1.

UDC 678.664:539.2

Partially-Interpenetrating Polymer Lattices Based on Lattice and Thermoplastic Polyurethanes

917D0038G Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 28-33

[Article by V. P. Kuznetsov, V. N. Lemeshko, Yu. V. Maslak and V. F. Rosovitskiy]

[Abstract] The authors studied the properties of polymer compounds with partially-interpenetrating lattice structure containing latticed and linear thermoplastic polyurethane, and the effect of the relative quantities of latticed and thermoplastic polyurethane on the formation process, the viscosity, physical and mechanical properties, thermal and viscoelastic properties of the partially-interpenetrating lattices. It was found that the gelatination time was lowered in compounds with elevated thermoplastic polyurethane content, confirming the results of rheological investigations. The intensity of the 2270 cm^{-1} IR absorption band characteristic of isocyanate groups was measured in order to study the effect of increased gel fraction and decreased isocyanate group concentrations on polymer formation processes. From this, and other properties, it is found that the optimum thermoplastic polyurethane content is in the neighborhood of 40 to 50 percent. References 7: Russian; figures 2; tables 2.

UDC 678.686.028:534-8

Characteristics of Epoxydiane Oligomer Curing in an Ultrasound Field

917D0038H Moscow PLASTICHESKIYE MASSY in Russian 09, Sep 90 pp 42-43

[Article by V. G. Makarov and M. V. Apukhtina]

[Abstract] The authors studied the curing of ED-20 epoxydiane resin in the presence of 9:1 polyethylenepolyamine at 281.5, 293, 303 and 313 K, and the effect of ultrasound at 60, 100, 400 and 1000 kHz on the dynamic viscosity of the curing process. The relationship between the log of the ultrasound frequency and dynamic viscosity was highly linear with positive slope, and was approximated by an exponential function. The slope, and hence the multiplier in the exponent, was found to depend on temperature in a complex fashion. The activation energy was found to be 16 kJ/mole, and this led to the conclusion that ultrasound was effective only in the diffusion region of the curing reaction. References 3: Russian; figures 1; tables 1.

UDC 678:66.063

Scientific Basis of Techniques for Manufacturing Elastomer Composite Materials

917D0039A Moscow KAUCHUK I REZINA in Russian Sep 90 pp 14-17

[Article by V. V. Bogdanov]

[Abstract] The author addresses general principles in the problem of establishing correlations between initial component properties, process regimes, equipment parameters and polymer-polymer mixing quality criteria, and the final product in the manufacture of elastomer composite materials. The shear deformation criterion γ is key to a qualitative and quantitative understanding of critical mixing quality, or better yet, the shear deformation dispersion $D(\gamma)$ at various points in the material. An example of its use for various synthetic rubbers is presented, showing a linear relationship between deformation dispersion and dispersion of added-component concentration. The author suggests that the Bogdanov-Torner (BT) criterion (mean square of $D(\gamma)$, similar to the Poltersdorf-Reher-Meissner M criterion) be the basis for future mathematical models of mixing processes. Discussion follows of use of this criterion, and choice of analytic or numerical solution, in cases involving roller, rotor, static, worm gear, electric motor-driven and pulsating rotor mixing equipment. References 7: 5 Russian, 2 Western; figures 4.

UDC 678.01.539.5

The Effect of Mineral Filler on the Rheological Properties of Combination Isoprene/EPD Blends

917D0039B Moscow KAUCHUK I REZINA in Russian Sep 90 pp 34-35

[Article by T. I. Igumenova, I. A. Ososhnik and V. S. Shein]

[Abstract] An 80:20 blend of isoprene (SKI-3S) and ethylenepropylenediene rubber (Keltan 512) was bleached with various combinations of silicon white synthetic filler (BS-120), lithopone and kaolin. Dispersion of these fillers was indirectly estimated from the maxima on an averaged curve of torsional moment vs. deformation time, as measured on a Monsanto 1500 viscosity meter at 100 <SDC, correlated to ultimate torsional strength for thixotropic structures. The resulting response function coefficients in the planning matrix for a 2^3 full factorial experiment with these filler combinations was used as a measure of this rheological characteristic for mixing times in a roller-type mixer of 0.5, 3, 6, 9 and 12 min. As expected, silicon white is the most active, promoting the dispersion of the other components. It is found predominantly in the polyisoprene phase with lithopone, leading to the conclusion that the kaolin precipitates into the interphase regions, stratifying the polymer system and reducing the strength of the thixotropic structure. References 5: Russian; tables 1.

UDC 678.746.222.002:543.544

Variation in the Molecular Mass Distribution of SKS-30AKRP During Thermal Oxidation Destruction

917D0039C Moscow KAUCHUK I REZINA in Russian Sep 90 pp 36-37

[Article by V. O. Yanchuk, M. I. Sokolov, G. S. Bryukhno and T. M. Besperstova]

[Abstract] Waste byproducts from synthetic rubber and latex manufacture can be recycled into stable, useful compounds by a method developed at the Synthetic Rubber SRI imeni S.V. Lebedev. The process consists of breaking up the polymer waste and adding it to a reactor with solvent, a catalyst and air at 120 to 130 |SDC; the viscosity increases and hydrogen-containing functional groups build up as the mixture oxidizes. Good adhesion and quick drying times lead to the use of this byproduct in latex paints, anti-corrosion coatings and road paving compounds. Commercial grade SKS-30APKR was subjected to this kind of oxidation; the solvents tested were xylol, nefras (10 percent solution with the rubber) and a 1:1 mixture of the two (20 percent solution with the rubber). After 1 to 2 h of oxidation, probes were inserted to determine the characteristic viscosity, and to take gel chromatographs from which the molecular mass distribution was derived. Results show that the oxidation proceeds faster in xylol than in nefras. References 6: 4 Russian, 2 Western; figures 1; tables 1.

UDC 621.762

Tolerances for Residual Deformation in Porous Bodies

907D0195A Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 6-8

[Abstract of article by V. Z. Midukov; Kramator Industrial Institute]

[Abstract] A mathematical approach to establishing tolerances for residual deformation in a porous body was presented. The calculations revealed that, regardless of the type of stressed state, both the tolerances for residual deformation and the yield point fundamentally depend on the noncompactness parameter of the material. It was shown that R. Green's criterion can be used to find specific tolerance values depending on porosity and different states of stress. References 3: 2 Russian, 1 Western.

UDC 621.762

Compacting Billets From Gas-Atomized High-Speed Steel Powders

907D0195B Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 9-12

[Abstract of article by G. A. Baglyuk, G. Ye. Mazharova, S. N. Kaplya, L. A. Poznyak, and R. Z. Vlasyuk; Institute of Materials Science, Ukrainian Academy of Sciences]

[Abstract] A study was done to determine the feasibility of cold pressing high-speed steel powders without preliminary pulverizing and the influence of various factors on this process. R6M5K5 powder quenched immediately after atomization was used. The fraction was 830 μm. After the powder was annealed to soften it, microhardness dropped from 7200—10300 MPa to 3030—4000 MPa. To improve compactibility, a plasticizing binder was added to the powder. It consisted of either homogenized paraffin or a rubber and gasoline solution and constituted 1 - 3 percent of the mixture. The mixture was air dried in a layer not more than 30 mm thick, then sifted through a sieve with a 1-mm mesh. The billets were pressed from two sides on a P-150 experimental compacting machine in a closed cylindrical mold 30 mm in diameter. The average ratio of billet height to diameter was approximately 1. The method proved to be feasible. The billets were relatively strong, especially those made with paraffin as the binder. Specimen strength increased to 1.7 kN when the paraffin content was decreased to 2 percent and pressing force increased to 1000 MPa. Compactability was not significantly affected by pressing force or the amount of binder. DRON-2 diffractograms showed that only elastic deformation occurs during the compacting process as long as pressing force remains within the recommended range of 600 - 800 MPa. It was recommended that the powder charge consist of unannealed powder mixed with paraffin, which is lost during the sintering process. Figures 5; references 5: Russian.

UDC 621.762

Kinetics of Sintering Titanium Carbide With Gadfield Steel

907D0195C Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 13-16

[Abstract of article by O. V. Yablokova and S. N. Kulkov; Institute of Strength Physics and Materials Science, Siberian Department of the Ukrainian Academy of Sciences]

[Abstract] The kinetics of the liquid-phase sintering of titanium carbide with Gadfield steel was studied. The TiC produced by the reduction was nearly stoichiometric. The Gadfield steel powder, which had a dispersity less than 50 μm, was made by atomizing the melt. A charge consisting of the steel and 30 - 40 percent TiC was mixed, pressed, and sintered in a protective argon or helium atmosphere at temperatures of 1520, 1570, 1620, 1670 and 1720 K for 30 min, and 1, 2, 3 and 6 hours. Specimen hardness, porosity and microhardness were measured. The specimens also underwent metallographic and phase analysis. Porosity decreased sufficiently within 1 - 2 hours at temperatures above 1570 K. The hardest specimens were obtained when sintered at 1670 and 1720 K for 2 hours. Longer sintering times result in lower hardness numbers. Metallographic analysis revealed two structural components: rounded carbide grains and steel binder. Higher sintering temperatures and prolonged sintering times improve structural uniformity, but have an adverse effect on carbide grain size (making the grains large and giving them a ringed structure) and steel microhardness. X-ray crystallography on a DRON-3 diffractometer using CuK_α radiation showed that sintering and higher temperatures for prolonged periods result in the formation of an α-phase and (Ti, Mn)C complex carbide. Sintering at moderate temperatures promotes the formation of the austenite-martensite structure in the steel binder. An increase in sintering time or temperature promotes intensive dissolution precipitation recrystallization, formation of an annular shell on the carbide, and formation of an austenite-pearlite structure in the binder. Figures 4; references 4: Russian.

UDC 621.762.4:666.3/.7:661.665.3:620.170

Structure and Properties of Hot-Pressed Ceramics Based on Boron Carbide

907D0195D Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 16-20

[Abstract of article by M. S. Kovalchenko, Yu. G. Tkachenko, V. V. Kovalchuk, D. Z. Yurchenko, S. V. Satanin, and A. I. Kharlamov; Institute of Materials Science Problems]

[Abstract] The structure and properties of hot-pressed B_4C—TiB_2—TiO_2 ceramic were studied. The ceramic was made from boron carbide, titanium oxide and carbon. Three types of boron carbide powder were used: abrasive powder and powders made by the solution method from boric acid and saccharose and from boric acid and carbon black. The powders were pulverized in a planetary grinder lined with boron carbide plates, using grinding tools made from hot-pressed boron carbide, then hot-pressed utilizing induction heating. Regardless of the type of boron carbide powder used, compaction and final density of the ceramics is greatly affected by the heating rate during hot pressing, with the greatest degree of compaction achieved at a heating rate of 50 deg/min. The best densities were achieved using the solution-produced powders. The final stage of hot pressing was done under isothermal conditions at the same pressure used for the non-isothermal stage. The final stage is characterized by compaction that accelerates over time. The experimental data on relative deformation were used to calculate the average quadratic deformation, average quadratic deformation rate, the functions describing dislocation creep, and the activation energy for accelerating creep in the ceramic. Maximum values for three-point bending strength (600 MPa), Vickers hardness (34.5 GPa), modulus of elasticity (450 - 470 GPa), and crack resistance (5 MPa x $m^{1/2}$) were obtained when the ceramic contained 15 - 20 percent TiB_2 by mass of the solution produced powders. Microhardness (indentor load 2 N) did not exceed 39 GPa. Figures 6; references 5: Russian.

UDC 621.762.5

Interparticle Bonding During Electropulse Sintering of Titanium Alloy Powders

907D0195E Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 20-23

[Abstract of article by P. A. Vityaz, V. M. Kaptsevich, K. Ye. Belyavin, T. Ye. Prezhina, L. F. Kerzhentseva, V. G. Govorov; Belorussian Republic Scientific Production Association for Powder Metallurgy]

[Abstract] VT-9 titanium alloy powder, made by atomizing a rotating electrode, was used to study changes in the microstructure of electropulse-sintered (EPS) powders. The alloy content was 5.8 - 7.0 percent Al, 2.8 - 3.8 percent Mo, 0.8 - 2.0 percent Zr, and 0.2 - 0.35 percent Si. The particles were spherical and had a fairly smooth surface. Due to the nature of the manufacturing process, different batches of the powder had different α-/β-phase ratios and a coarser dendritic structure in particles having less of the β-phase. Metallographic analysis showed that, in contrast to traditional sintering, EPS did not appreciably affect the shape or microstructure of the particles, as the fusion of the metal took place only in the contact zone as a result of localized Joule heat release. Concentration curves recorded on an MS-46 Kameka (France) revealed that low-temperature modification of the α-Ti and high-temperature modification of the β-Ti occurs, and that Al stabilizes the α-phase, while Mo stabilizes the β-phase. Metallographic data confirmed that chemical composition of the original powder is not affected by electropulse sintering. Figures 5; references 1: Russian.

UDC 621.762

Relationship Between Properties, Pressing and Sintering Conditions, and Pore Structure of Niobium Powders: III. Pore Structure of Materials Made From Sintered Niobium Powder

907D0195F Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 23-28

[Abstract of article by Yu. V. Levinskiy, A. B. Zaytsev, Ya. M. Polyakov, Yu. B. Patrikeyev; Moscow Institute of Fine Chemistry Technology]

[Abstract] A study was done to determine the relationship between the pore structure of sintered niobium, its dispersivity, the density of the preforms, and the sintering conditions. This part of the study focused on the nature of the pore structure of sintered niobium powder materials. Specimens were pressed from three different batches of niobium powder. Mercury porometry and scanning electron microscopy were used to study pore structure. The basic characteristics studied were pore radius (r), pore distribution by size, and the correlation between closed and open porosity. In powders from batches 1 and 3, rapid growth in r gave way to a gradual decrease in r as sintering times (up to 120 min) and temperatures (1200, 1300, 1400, 1600, 1800°C) were increased. This function was essentially the same for batch 2, but somewhat more complex in that the decrease in r was non-linear. Pore size range was greatest in the green compacts, which also had a significant quantity of tiny pores. After sintering for 5 minutes, the spread in pore size decreased, and the smallest pores disappeared. The quantity of large pores also decreased somewhat. With an increase in sintering time, pore size distribution became much more uniform; at 120 minutes, the curve was shifted in the direction of decreased pore radius. When sintering highly porous specimens from highly dispersed powders, zonal particle isolation occurs at 1600°C within the first five minutes. A linear relationship exists between average pore radius and total pore volume for identical sintering conditions. The correlation between closed and open porosity depends completely on total porosity, not sintering conditions. Figures 5; tables 1; references 2: Russian.

UDC 621.762

Structure and Properties of Iron-Copper-Tin-Lead Antifriction Powder Materials

907D0195G Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 34-38

[Abstract of article by N. G. Baranov, V. S. Ageyeva, L. V. Zabolotnyy, A. I. Ilnitskaya, V. S. Mokrovetskaya, V.

Ya. Sabaldyr; Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] The structure, frictional properties, and some mechanical properties of iron-copper-tin-lead antifriction powder materials were studied. The materials were made from PS-1 lead powder, PO1 tin powder, PMS-1 copper powder, and PZhZM2 iron powder, which contained 0.3 percent O_2, 0.07 percent C, 0.05 percent Si, 0.16 percent Mn, 0.02 percent P, and 0.01 percent S (by mass). Total copper and tin content was 4 percent; total lead content was 15 percent, also by mass. Prior to sintering, the compacts were double-pressed and sintered. The structure of the materials was studied using a method that integrated x-ray microanalysis on a Superprobe-733, x-ray crystallography on a DRON-3 in FeK_α radiation, and scanning electron microscopy. Porosity was not less than 7.2 percent and was not greatly affected by sintering. Mass decreased slightly after the first sintering, but increased somewhat in some specimens after the second sintering. Intense volatilization and sweating out of the lead was not observed. The structure of the material consists of an α-solid solution of iron with uniform distribution of lead inclusions and a homogeneous Cu-Sn phase. Friction and wear were tested face-to-face on cylindrical specimens 15 mm in height and diameter in an argon or air atmosphere on a stand designed by the Institute. The overlap coefficient was 0.15, 07Xh16N6 steel served as the abradant, total test time was 180 s, the slide rate was 11 m/sec, and pressure was 1 MPa. In the argon atmosphere, the friction coefficient was 0.15, and wear intensity was 5.4 μ/km. Hardness, impact toughness, and radial compressive strength were tested and proved to be satisfactory (950 MPa, 7.1 J/sq cm, and 530 MPa). Fracturing that occurred during impact testing was brittle in nature. Figures 2; tables 1; references 18: 13 Russian, 5 Western.

UDC 661.665.3

Structure, Physical and Mechanical Properties, and Failure Behavior of Hot-Pressed Ceramics Based on Boron Carbide

907D0195H Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 38-43

[Abstract of article by O. N. Grigoryev, V. V. Kovalchuk, V. V. Zametaylo, R. G. Timchenko, D. A. Kotlyar, and V. P. Yaroshenko]

[Abstract] The structural, physical and mechanical properties, and failure behavior of single-phase boron carbide, as well as of materials based on it, were studied. The powders used in the study were synthesized from the elements or by thermal reduction. Silicon, titanium and zirconium oxides were added to the charge to produce B_4C—SiC, B_4C—TiB_2, and B_4C—ZrB_2 ceramic materials. Carbon black was also added to ensure completeness of the chemical reaction. The specimens to be studied were hot-pressed with induction heating in carbon refractory molds using BN-based protective lubricant. Bending strength was tested on an R-0.5 tensile testing machine. The microstructure was studied with optical and scanning electron microscopy. Cracking resistance was measured by applying a bending load to notched bars on a 1958U10 universal testing machine and also by microindentation. Vickers hardness was tested on a TP-7R-1 using a 10-N load. The indentor of this machine was also used under a load of 100 N for the microindentation cracking resistance test. Young's modulus was determined from the speed at which an ultrasonic signal passed through the specimen. The single-phase boron carbide had non-uniform pore structure, grain growth and grain size and relatively low cracking resistance, and strength as low as 200 MPa. The tested properties improved significantly when the second phase constituted up to 15 percent of the ceramic. A higher percentage resulted in the deterioration of some of these properties, especially cracking resistance. Maximum values were about 470 GPa for Young's modulus, 700 MPa for bending strength, 35 for Vicker's hardness, and 6 for cracking resistance. These properties are sufficient to allow using the two-phase ceramics for industrial purposes. Figures 7; tables 1; references 12: 5 Russian, 7 Western.

UDC 621.762

Effect of Temperature on the Properties and Plasticity of Powder Steels

907D0195I Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 43-48

[Abstract of article by B. S. Yermakov, S. S. Yermakov, and E. A. Suleymenov; Leningrad Polytechnic Institute]

[Abstract] The plasticity of carbon steels subjected to short and long term (up to 1 h) deformation tests within a temperature range of 20 to 600°C was studied. Compacts 12 by 12 by 65 mm were sintered for 3 hours at 1150°C in an ammonia atmosphere, then machined to the proper size and shape. One batch contained 0.19 - 0.22 percent carbon, had a porosity of 8 - 10 percent, and was designated SP20. The other batch, labelled SP55, was 0.54 - 0.57 percent carbon and had a porosity of 14 - 16 percent. Both types of steel were made from PZh2M2 iron powder. At deformation rates between 0.01 and 314 percent, the plasticity of the SP20 specimens decreased at temperatures up to 250°C. Plasticity improved at temperatures up to 475°C, after which embrittlement of the steel was observed. Minimal plasticity between 175 - 250°C was attributed to the effects of strain aging during prolonged loading, which are manifested in the formation of dispersed Me_3 type carbide particles. The carbide formation leads to reduced cohesion between the grains and particles and promotes interparticle and intergrain cracking sufficient to cause specimen failure. At temperatures between 375 - 475°C, temperature weakening of the matrix occurs, and the relaxation of stresses in the microcrack nuclei ensures maximum plasticity and a transition from brittle to

ductile failure. Generally, a lower rate of deformation decreases plasticity and reduces the temperatures at which discontinuities in the strength and plasticity curves are encountered. The SP55 specimens had poor strength and plastic properties at the various loading rates and temperatures studied. The mathematical relationships between long-term failure and plasticity at various temperatures and loads were established. SP20 steel is sensitive to delayed failure at temperatures below 200°C and above 475°C. At temperatures between these values, this steel is vulnerable to high rates of loading. Figures 5; tables 2.

UDC 621.762

Scaled Classification of the Internal and External Properties of Metallic Powders and Composite Materials Based on These Powders

907D0195J Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 48-55

[Abstract of article by M. M. Khvorov, T. M. Shvets; Institute of Colloid and Water Chemistry, Ukrainian Academy of Sciences]

[Abstract] A system was developed for classifying the properties of metallic powders and related composite materials. The system classifies these properties according to whether they are external or internal and whether the specimens or specimen components used to study these characteristics are macroscopic (Category I), microscopic (Category II), or submicroscopic (Category III) in nature. Each category is subdivided to accommodate internal and external characteristics. The system includes 24 categories of the geometric, structural, physical and chemical characteristics of the materials under consideration. The system was used to formulate a set of mechanical, magnetic, and electrophysical properties for magnetic recording media (disks and tapes) made from metallic powder-based composite materials. Figures 3; references 9: 7 Russian, 2 Western.

UDC 621.892.8(088.8)

Effect of Lubricant Composition on Friction Processes in Powder Bearings

907D0195K Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 69-74

[Abstract of article by S. N. Silnyagin, Yu. I. Pustovoyt, Yu. A. Yevdokimov; RostNIITM Production Association]

[Abstract] A study was done to determine whether powder bearing self-lubrication could be improved by adding tribopolymer-forming and gas-forming additives to the impregnating lubricants. Five different lubricant compositions were tested: 1) I-30A oil, 2) I-30A oil/N-methylpyrrolidone (N-MP), 3) I-30A oil/N-MP/2 percent ChKhZ-57 (trade name for 2,2-azobisisobutyronitrile, a chemical gas-forming additive), 4) I-30A oil/50 percent EF-357 (tribopolymer-former), and 5) I-30A/EF-357/ChKhZ-57. The tests were conducted on an SMTs-2 friction machine. Friction surface topography was studied on a Neofot-2 optical and a Jeol electron microscope. Microhardness was studied on a PMT-3 microhardness tester using a load of 0.2 N, and microgeometry on a Kalibr-201 profilograph. Tribochemical changes in the lubricant during the course of the friction tests were analyzed from IR absorption spectra on a Specord 75JR spectrophotometer. The first part of the study involved express-testing the lubricants for their running-in effects on oil-starved rollers. The stationary specimen was made from pre-pregged ZhGr1.5D2.5 iron graphite powder with 20 percent porosity. The abrading specimen was made from St40Kh steel with 51-52 HRC. A shaft/bushing arrangement was used to test the effectiveness of the triborelaxation processes. Lubricants 3, 4 and 5 had the best running-in, anti-scoring and anti-wear properties, with 3 having the best overall combination of properties. It was the most effective lubricant for running-in the specimens, and it promoted the formation of a highly adhesive polymer film on the abradant. Field tests of powder bearings impregnated with the number 3 lubricant and used in the idler sprockets of Niva and Don-1500 combines and other agricultural equipment showed wear not exceeding 0.03 - 0.05 mm during one harvest season. Figures 4; tables 1; references 11: Russian.

UDC 621.763:539.374:548.73

Thermal Stability of In Situ Produced Copper-Niobium Composites

907D0195L Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 74-80

[Abstract of article by V. A. Bliznyuk, I. A. Kiyanskiy, I. S. Dukhovnyy, V. P. Oleshko, G. V. Berdichevskiy; Horizon Experimental Design Office, Moscow]

[Abstract] The thermal stability of niobium fibers in Cu 20 percent Nb microcomposites was studied. A mixture of niobium and copper powders (average particle size 50 and 20 μm, respectively) was placed in a copper container, hydroextruded, and drawn to form wire 0.7 mm in diameter. The specimens were vacuum annealed (about $6.65(10^{-3})$ Pa for 2 to 100 hours at 550 - 900°C, + 10°C. Critical current was measured using the standard four-point method at 4.2 K in a field of 0 to 0.5 teslas. Specimen structure was studied on longitudinal and transverse sections using a JSM-35CF and a JSM-T300 scanning electron microscope made by the Jeol firm, with an accelerating voltage*** of 25 kV. The secondary electron images obtained were magnified 100 to 10,000 times. A special technique had to be used to obtain the 0.03 to 0.04 μm resolution required to study the specimens. It involved mounting the specimens in epoxy resin and adding Ti powder to ensure electrical conductivity. The specimens were then etched at room temperature with a mixture of phosphoric, glacial acetic, and nitric acids. The data revealed that Ostwald coalescence takes place depending on the temperature and duration of

annealing, i.e., the fine fibers are dissolved and the dissolved Nb atoms are transferred to and deposited on the adjacent thick fibers. This process is accompanied by the structural coarsening of the microcomposite, which is caused by surface tension running in the direction of the decrease in the copper/niobium boundary energy. The rate at which the microstructure is modified depends on the mass transfer of niobium through the copper matrix. Using a model describing the change in the shape of fibers in directionally crystallized eutectics, it was found that the critical diameter of fibers spheroidized during a given annealing period can be defined as $\tau^{1/3}$. Figures 5; tables 2; references 12: 5 Russian, 7 Western.

UDC 621.762.4:661.55:669.018.45:620.179

Structure and High-Temperature Strength of Sintered TiN-Ni Materials

907D0195M Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 80-83

[Abstract of article by F. F. Yegorov, Ye. I. Ivanov, A. M. Shatokhin; Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] The high-temperature strength and failure characteristics of TiN-Ni materials as a function of their structural features were studied. Specimens were compacted from $TiN_{0.99}$ powders containing 0.4 percent Fe and O_2 impurities and 10, 20 and 30 percent electrolytic nickel, then subjected to high-temperature liquid-phase sintering in an SShV furnace in an especially pure argon atmosphere at a pressure of $0.35(10^5)$ Pa. Strength was tested using a concentrated load on specimens 5 by 5 by 35 mm polished to a surface roughness of 0.18 μ. The tests were performed on an R2/2300-type machine at high temperatures in a pure argon atmosphere. The specimens were loaded after isothermal soaking for 10 minutes at the test temperature. The load bar moved 0.5 mm/min. Material strength changed little as temperature and nickel concentration were increased. In specimens containing 30 percent nickel, bending strength decreased gradually to about 0.5 GPa as the temperature was increased to 900°C, at which point it fell sharply. At room temperature, failure was predominantly brittle with slight microplastic deformation of the nickel carburizing binder. At 300°C and higher, plastic deformation of the binder increased dramatically. However, only that part of the binder consisting of the solid solution of titanium in nickel was affected by the plastic deformation. The marked drop in strength at 900°C is brought about by the solid phase grains slipping along the interphase boundaries, which are weakened by the appearance of a liquid eutectic phase at this and higher temperatures. Figures 4; references 3: Russian.

UDC 539.2:669.018:620.187

Structure of Silicon Nitride-Based Hot-Pressed Ceramics With an Aluminum Oxide Activator

907D0195N Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 88-92

[Abstract of article by V. A. Melnikova, L. F. Ochkas; Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] The microstructure of ceramics based on β Si_3N_4 with an aluminum oxide activator was studied. The activator content varied between 5 and 20 percent. The ceramic was hot-pressed at a pressure of 30 MPa and a temperature of 1750°C for 15 minutes. The original charge was ground by hard-alloy balls and consisted of monocrystalline particles that were most likely 1.6 μ in diameter. Phase composition, dispersity, flaws and binder phase distribution were studied radiographically and electron microscopically in the ceramic's fractures and in foils of the material thinned by ion bombardment. The formation of the ceramic's structure is characterized by formation of new phases (amorphous binder and secondary crystalline compounds), plastic deformation of the silicon nitride grains and their recrystallization through the melt. Mechanical properties depend on the quantity of the binding phase and are determined by the characteristics of crack propagation in specimens with different component ratios. The aluminum oxide content corresponding to the highest mechanical values was 7 percent. At this concentration, microhardness was 15.7 GPa, ultimate bending strength was 450 MPa and ultimate compressive strength was 1200 MPa. Increasing the aluminum oxide content to 20 percent of the charge reduced these numbers to 148, 350, and 850, respectively. Figures 5; references 8: 2 Russian, 6 Western.

UDC 621.762:669.018.25

Feasibility of Grinding Hard-Alloy Mixtures in Aqueous Solutions

907D0195O Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 90 pp 98-100

[Abstract of article by V. M. Zanozin, R. V. Rybalchenko, Yu. M. Polukarov, A. F. Presnyakova, G. P. Samoylova; VNII of Refractory Metals and Hard Alloys, Institute of Physical Chemistry of the Ukrainian Academy of Sciences]

[Abstract] The effect of using water as a grinding fluid on the properties of VK6 tungsten carbide mixtures and sintered alloys was studied. The components were briefly ground in a laboratory ball mill. One batch was made in the conventional manner from an "alcohol" mixture,

and four from "water" mixtures, which were air- or hydrogen-dried to form briquets. The compressive strength (N/sq mm) of the green briquets formed from one of the air-dried water mixtures was 3.94, whereas that of the green briquets formed from the alcohol mixture was 0.03. Capillary contraction alone does not suffice to explain the difference in strength values. Water possibly has a plasticizing effect on the particle surfaces and this, together with the contraction, promotes the formation of sufficiently strong phase contacts. Also, the large number of water-soluble impurities in the VK6 could promote the formation of crystallization contacts between the particles. Rinsing the water mixtures with alcohol reduced briquet strength to 0.84 by reducing surface tension and removing the water-soluble impurities. Hydrogen drying of the aqueous mixtures almost completely eliminated the aggregation effect of dessication, but reduced briquet strength to 0.14. However, it did not appreciably influence the bending strength (N/sq mm) of the sintered specimens, which was 1490 for the air-dried batch, 1520 for the hydrogen-dried batch, and 1500 for the alcohol-rinsed batch. The addition of a [unidentified] surfactant to the water mixture increased bending strength of the sintered specimens to 1720. The bending strength of sintered specimens made from the alcohol mixture was 1760. There was no appreciable difference in density or hardness between the alcohol and water batches. Figures 1; tables 2; references 5: Russian.

UDC 621.762.5:669.14.018.8:621.762

Structure and Properties of Corrosion-Resistant Steel-Based Powder Materials

907D0197H Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 50-51

[Article by S. B. Boshin, S. P. Nezamayev, Kostroma Technological Institute and the Motordetal Plant]

[Abstract] Composite antifriction materials are being increasingly used as friction joints in the textile industry. The structure, phase composition and antifriction properties of powder materials made from corrosion resistant steel PKh18N15 are examined. The microstructure of samples was examined by light microscopy, the phase composition—by X-ray phase analysis using iron K_α radiation, and microhardness—by a PMT-3 instrument. It is shown that the powder material microstructure consists of doped austenite and molybdenum-rich areas, a small amount of ferrite, chromium, molybdenum, and tungsten carbides, cementite, intermetallides, tungsten disulfide inclusions, granules of steel PKh18N15, voids, and graphite in pores. It is established that the microstructure of the two types of samples obtained differs primarily in the concentration of phase components. It is shown that powder materials under study can be recommended for making thread guides in textile machine instead of steel A12. References 4: Russian; figures 1; tables 1.

UDC 621.9.048:669.24'779:62-761

Structure and Property Variations in Chemically Deposited Ni-P Coats During CW CO_2 Laser Fusion

907D0197A Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 16-19

[Article by A. B. Lysenko, N. N. Kozina, Dneprodzerzhinsk Industrial Institute]

[Abstract] Laser amorphization or glazing of the surface are expected to improve the properties of structural materials since amorphous metallic alloys exceed similar crystalline alloys with respect to corrosion resistance, strength, hardness and wear resistance indicators, although implementation of the glazing process is constrained by a number of factors. Changes in the phase content, microhardness and microstructure during the fusion of Ni-P coats with the steel base by a CW CO_2 laser are examined. Coats were deposited from aqueous solutions on high-temperature hardened steel 45 bases. The microstructure was examined by a light microscope and a scanning electron microscope. It was established that during the treatment of Ni coats with 12 percent P on a steel 45 base at a power density of 60 - 100 MW/m^2 and a beam scanning rate of up to 200 mm/s and a fusion rate of 1.0 - 3.3, no secondary amorphization of the fused layer is observed. The microstructure of the fused areas consisted of dendrites and a solid solution with a FCC lattice and a eutectic component whose amount decreased with the fusion depth; the laser alloying area's microhardness (360 - 450 H) was comparable to that of amorphous deposits yet somewhat lower than that of similar coats annealed for an equiphase composition at 490°C. References 5: Russian; figures 3; tables 1.

UDC 621.785.539:621.791.72:669.14.018.29

Structure Formation of Steel Surface Layer During Laser Borating-Chromizing

907D0197B Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 19-22

[Article by V. S. Postnikov, V. S. Tomsinskiy, A. S. Polyakov, Perm Polytechnic Institute]

[Abstract] The surface layer structure is studied during the concurrent alloying of normalized steel 45 with chromium and boron carbide by laser. It is found that during pulsed laser irradiation of the surface of steel covered with a boron-containing coat, highly disperse boride phase formation processes occur in the melting zone which considerably increase the surface hardness; when borated with pure boron carbide, the fusion zone has a very disperse granular structure but in the presence of chromium in the coat, the fusion zone acquires a ledeburite-like dendritic structure. Moreover, the structure of the surface layer obtained by laser-induced borating-chromizing has a high thermal stability at 860°C while subsequent cooling in the air does not result in a significant layer hardness degradation. References 9: 6 Russian, 3 Western; figures 2.

UDC 621.9.048:669.14.254

Effect of Electron Bombardment Conditions on Resistance of Forming Parts of Dies

907D0197C Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 22-24

[Article by V. B. Lifshits, R. A. Vladimirskiy, N. V. Morozova, Ye. M. Fridman, the Temp Scientific Production Association]

[Abstract] The effect of high-energy electron irradiation conditions on the diffusion process kinetics in 4Kh5MFS steel samples after their surface saturation with various elements are examined and the resistance of forming parts of dies (FPCh) made from this steel exposed to a similar treatment is analyzed. It is established that the diffusion layer thickness in the samples irradiated with 8 MeV electrons increases faster than in the case of a 4.5 MeV electron energy given the same heating temperature while the increase in the diffusion layer depth of samples irradiated at 550°C is considerably higher than that of samples irradiated at 450°C. The die resistance also reaches its maximum after an irradiation at 550°C. As the irradiation energy rises, the die resistance maximum shifts toward lower temperatures. It is possible to speculate that although an irradiation energy increase leads to the formation of a large amount of point defects, the irradiation temperature has the greatest effect on the diffusion processes leading to changes in the diffusion layer and die resistance. It is demonstrated that irradiation of parts subjected to chemical heat treatment beforehand helps to increase the diffusion layer thickness while the rate of the diffusion processes occurring in them is higher than the thermal diffusion rate. Electron irradiation of forming parts of dies increases their hardness and resistance but calls for an additional study of the process allowing for the part material composition. References 1; figures 3.

UDC 669.295.5:621.3.032.26

Ion Beam Modification of Titanium Alloy Surface Layers

907D0197D Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 24-29

[Article by V. A. Shulov, Yu. D. Yagodkin, A. M. Sulima, V. V. Tetyukhin, Moscow Aviation Institute and Scientific Production Association of the All-Union Aviation Materials Institute]

[Abstract] Research data in the area of ion implantation in titanium and its alloys by ion bombardment are classified based on a unified principle: initial state—ion implantation—heat treatment—operating tests—final state. In particular, the following specific features of ion implantation are examined: The physical and chemical state of surface layers of titanium alloys before and after doping; friction, wear and resistance to dust erosion; endurance strength; and corrosion resistance. An analysis of published data dealing with the effect of ion implantation on the operating properties of titanium alloy products shows that ion doping can considerably increase the corrosion and erosion resistance, endurance and wear resistance, friction resistance, and high-temperature strength. An optimum bombardment condition must be selected for each alloy and in so doing, special attention must be focused not only on the ion energy and exposure dose but also on the ion current density. It is demonstrated that if the part to be treated must operate at elevated temperatures, stabilizing annealing is necessary after the ion bombardment. References 22: 16 Russian, 6 Western; figures 4; tables 2.

UDC 621.785.545:669.14.018.294.2

Heat Treatment of Rail Steel by Induction Heating

907D0197E Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 90 pp 30-34

[Article by D. K. Nesterov, V. Ye. Sapozhnikov, N. F. Levchenko, V. A. Dubrov, Ukrainian Scientific Research Institute of Metals]

[Abstract] Rails in the USSR are made from high-carbon M76T eutectoid steel. A comprehensive study of the structural transformations occurring in austenite during rapid heating as well as the main characteristics of carbon rail steel (hardness penetration, hardenability, tendency to austenite grain growth, and the austenite decay rate during continuous cooling as well as under isothermal conditions) is carried out in order to develop optimum rail heat treatment conditions. Open-hearth carbon rail steel M76T was examined. Samples were heated within a 740 - 930°C range at a 10°C/s rate and then cooled in water. Phase and structural transformation kinetics were analyzed. The results of experiments carried out under industrial conditions show that a decrease in the RF induction heating temperature with an optimum distribution of the power input results in a total pearlite-austenite transformation during the heating and a hardening structure formation during the cooling. A study of structural transitions and technological features of rail steel after the accelerated heating shows that the rail transport speed can be increased to 45 - 48 mm/s vs. the design value of 40 mm/s while insuring good physical and mechanical properties and structural strength. The operating resistance of rails hardened after RF heating vs. the nonhardened ones is 50 percent higher. References 10: Russian; figures 4.

UDC 669.18-412:621.746.6

Increasing Metal Quality by Efficient Chilling and Heating of Ingots

917D0025A Moscow STAL in Russian No 9, Jul 90 pp 67-70

[Article by Y. I. Tyurin, V. I. Legenchuk, V. A. Kaptyurov, Ye. L. Brechko and V. F. Chistyakov, Red October Metallurgical Plant and the USSR Academy of Sciences Foundry Problems Institute]

[Abstract] The latent heat in the phase transition from liquid to solid may be utilized to help heat an ingot during rolling by setting ingots into the soaking pit with higher than normal heat content; this is achieved through interdendritic spaces of 30 to 50 percent in the central regions of the liquid phase ingot. Motion of the phase boundary in a 6.5 ton cooling ingot of 12Kh1MF steel was studied experimentally and with computer modeling. Usually ingots are set into the soaking pits only after they have completely hardened in the mold (3 h 40 min), but it was found that cutting this down to only 1 h 40 min increased the hardening time by only 10 min and had no impact on the phase boundary motion or steel quality. Rejects due to cracking fell by 22.4, 35.3, 59.2 and 27.3 percent for manufacture of 20K, 10 - 50, 15Kh - 50Kh and 12Kh1MF martensitic steels, respectively; rejects due to macrostructural defects also fell significantly for all but 20K steel. Apparently this is due to the fact that the test ingots did not go through the allotropic transition, and they were rolled when their centers where still 66°C hotter than under usual conditions. The economic effect of this accelerated hardening procedure is about 2 rubles per ton of steel. Figures 2.

UDC 621.766.628

Manufacture of Railway Wheels From Individual Billets

917D0025B Moscow STAL in Russian No 9, Jul 90 pp 70-72

[Article by V. F. Polyakov, V. V. Klevakin, V. Ya. Minevich, Yu. P. Kosenko and L. A. Moyseyeva, Ferrous Metallurgy Institute]

[Abstract] The waste in making the top and bottom cuts, trimming the bosses and removing flash during manufacture of railway wheels is 20 to 24 percent using current techniques. The authors propose reducing this waste down to three to five percent by using individually poured billets, thus eliminating the need for so many trim cuts. Mathematical modeling of the crystallization process and physical modeling of free setting of the billet was conducted to study ways of getting blanks in which most of the draw is removed when the boss is extruded

and most of the impurities and surface draw inclusions are located at the ends rather than the rolling surface of the wheel. Best results are obtained when the top surface of the ingot is jacketed with an exothermic mixture to hold in the heat; the draw defects formed on the billets are then very shallow, open and/or close to the surface. The billet is free of the V-shaped macroscopic segregation and other visible defects characteristic of ordinary ingots, and is more dense. The billets passed all applicable standard tests. The authors indicate that more work needs to be done on identifying the most efficient variants and techniques for application of this method. Figures 2.

UDC 621.771.23:621.96

Using Highly Pressurized Water for Cutting Metals

917D0025C Moscow STAL in Russian No 9, Jul 90 pp 82-85

[Article by V. I. Andreyev, V. G. Sitalo, V. S. Shelest and V. I. Purtskhvanidze]

[Abstract] The authors describe and report on experimental and industrial testing of a new cutter for paper, cardboard, cloth, wood, leather and rubber using a thin stream of high pressure water. Two hydraulic units operating in tandem provide a stream of water under 150 to 800 MPa pressure through a 0.15 mm nozzle at a rate of 500 to 1000 m/min, consuming 8 to 80 KW of power. This hydraulic system has been installed in two different table configurations: A standard cutter that can cut non-metal sheet parts up to 450 x 450 mm, and one that can cut similar parts up to 1000 x 1500 mm. The increased cutting power and speeds (e.g., 50 mm-thick rubber at 200 mm/min) is due to the injection of an abrasive into the stream inside the nozzle. The abrasive is ordinary river sand, 0.25 to 0.5 mm in size, mixed at 0.2 kg/min with 200 MPa water flowing at 1.0 l/min. The cutter was tested on metals, e.g., 0.20 to 0.25 mm wide cuts were made in 5.0 mm thick titanium at a rate of 50 mm/min. By analogy with foreign high pressure water cutters such as the Woma (FRG), the authors recommend increasing the flowrate to 3.0 to 5.0 l/min under 300 MPa pressure, and replacing the sand with synthetic corundum of the same grain size. References 2: Russian; figures 3; tables 2.

UDC 669.14.018.26

Problems of Manufacturing High-Strength Rolled Stock

917D0025D Moscow STAL in Russian No 9, Jul 90 pp 92-93

[Article by N. F. Bakhcheyev, A. A. Vostrikov, N. N. Karagodin and I. Yu. Nadeina, Magnitogorsk Metallurgical Combine]

[Abstract] The authors describe two methods being investigated now at Magnitogorsk for improving the quality of rolled stock. The first is microdoping 10YuT and 20YuT steels with aluminum and titanium rather than scarce manganese; this steel now has fine uniform No 9-10 ferrite grains, fine titanium carbonitrides, a stronger matrix, aluminum nitrides for better texture, and improved stamping characteristics. The Combine delivered 20,400 t of 10YuT in 1989; both steels are used widely in the automotive and truck industry. The second method under study is reduction of the temperature at the end of the stock rolled on the TU 14-1-3023-80 by 30 to 50 <SDC and a lower temperature during reeling; this combination seems to provide better strength and plasticity characteristics. The authors estimate that the better steel could result in savings of 15 to 20 percent by virtue of longer service life for parts. However, they report that purchasers are not sufficiently informed about how to exploit the quality of the new steel and are not using it because of its higher cost, despite the fact that they could realize savings in metal that would more than make up for it. References 3: Russian; figures 1.

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